INTERNATIONAL STANDARD

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Ductile iron pipes and fittings — Seal coats for cement mortar linings

Tuyaux et raccords en fonte ductile — Seal coats pour les revêtements de mortier de ciment

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16132 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

Introduction

The intended purpose of a seal coat is to reduce the contact between a cement mortar lining and the contents of a water main, thereby restricting the leaching of inorganic materials into the water supply.

Seal coats are usually specified where the pipeline is to convey soft waters and/or where residence times are very long. Supply water quality data for such pipelines should be discussed between the prospective client and the seal coated pipe supplier to ensure the suitability of the product for use.

Attention is drawn to the fact that seal coated cement mortar lined surfaces in contact with, or likely to come into contact with, potable water need to conform to the requirements of national or international water supply or water quality regulations. Approval may be required for the individual components of the system — or for the combined system — depending upon the requirements of those national or international water supply or water quality regulations when used

— in accordance with the product manufacturer's instructions for use; and

— under any other appropriate conditions defined for that product within any published list of substances, products and processes approved to those Water Supply or Water Quality Regulations.

Ductile iron pipes and fittings — Seal coats for cement mortar linings

1 Scope

This International Standard specifies the requirements for seal coatings for factory application to the surfaces of cement mortar linings, which are factory applied to the interior of ductile iron pipes and fittings.

It also gives performance test requirements for short term sealing efficiency and long term durability and requirements for routine testing for visual appearance, coating thickness and adhesion.

This International Standard is applicable to products for potable and other water applications.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2439:1997, *Flexible cellular polymeric materials — Determination of hardness (indentation technique)*

ISO 2808, *Paints and varnishes — Determination of film thickness*

ISO 10523, *Water quality — Determination of pH*

ASTM D3330-02, *Standard Test Method for Peel Adhesion of Pressure Sensitive Tape*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given below apply.

3.1
ductile iron
cast iron in which graphite is present in substantially spheroidal form

3.2
fitting
casting other than a pipe, which allows pipeline deviation or change of direction or bore

NOTE Flanged-socket pieces, flanged-spigot pieces and collars are classified as fittings.

3.3
test film
film of consistent thickness and density, morphologically stable at the temperature of the substrate during seal coat application, used as a surrogate surface for the measurement of coating thicknesses

3.4
pipe
casting of uniform bore, straight in axis, having spigot, socket, flange or plain ends

NOTE This does not include flanged socket pieces, flanged spigot pieces and collars, which are classified as fittings.

3.5
product
seal coated, cement mortar lined iron pipe or fitting

3.6
seal coat
coating applied over a cement mortar lining to control the interactions between the lining and the contents of the conduit

3.7
performance test
proof of design test, done once and repeated only after a relevant change of material or supplier of the seal coat or lining, or relevant change in process design

4 Performance test requirements

4.1 Short term sealing efficiency

When tested in accordance with Annex A, the pH of the test water shall not exceed 9,5.

By agreement between the manufacturer of the product and the customer, other performance tests with other exposure periods, test waters and/or limits of pH value may be undertaken to suit particular national or customer requirements.

4.2 Long term efficiency

When tested in accordance with Annex B, the pH of the test water shall not exceed 9,5 for each of the test samples.

By agreement between the manufacturer of the product and the customer, other performance tests with other exposure periods, test waters and/or limits of pH value may be undertaken to suit particular national or customer requirements.

However, if the seal coat has been tested and documented by the manufacturer to a national standard and successfully used for a minimum of five years, the performance of the type test in accordance with Annex B is only required for significant changes in the coating material, type or formulation which could adversely affect the performance of the seal coat.

5 Routine Test Requirements

5.1 General

Coating and re-work procedures (e.g. drying regimes for solvent-based coatings and mixing and curing regimes for multi-component materials) shall be defined by the manufacturer of the product in agreement with the seal coat supplier, if necessary, so as to enable the product to conform to the requirements of this International Standard.

The tests specified in 5.2 to 5.4 shall be carried out on factory seal coated pipes or fittings as opposed to separately prepared test pieces.

Sampling plans for the tests specified in 5.2 to 5.4, specific to the seal coating material used, the size of the batch and the storage conditions, shall be specified by the manufacturer of the product for each batch of product.

Where a non-conforming product is identified, the product shall either be re-worked, so that it meets the requirements of this International Standard, or be rejected.

5.2 Visual appearance

When examined visually, the seal coat shall be free from any coating irregularities likely to be detrimental to the performance of the seal coat (as required by the performance tests in this International Standard). The manufacturer shall define those coating irregularities (e.g., hairline cracks or pinholes) which are considered not to be detrimental to the performance of the seal coat (as required by the performance tests in this International Standard), taking into account the nature of the seal coat material.

5.3 Coating thickness

When tested in accordance with Annex C or any appropriate method defined in ISO 2808, the wet or dry coating thickness shall be within the limits specified by the manufacturer of the product in conjunction with the seal coat supplier, if necessary.

5.4 Adhesion

When tested in accordance with Annex D, one of the following requirements shall be met:

— where a cross cut is made in the seal coat, the adhesive strength shall fall within the range of 1 to 3; or

— where no cross cut is used, the area of disbonded coating shall be less than 10 % of the test area.

Any area damaged during testing shall be repaired in accordance with a procedure defined by the manufacturer of the product in agreement with the seal coat supplier.

6 Marking

Each seal coated pipe or fitting shall be identified with the pipe manufacturer's name or mark.

In addition, seal coated pipes shall be indelibly and legibly marked on the external surface with the number and year of this International Standard.

NOTE Where pipes are bundled, the required markings may be applied to the bundle rather than to individual pipes.

Annex A
(normative)

Short term sealing efficiency

A.1 Principle

The initial or short term sealing efficiency of a seal coat applied to a cement mortar lined surface that is exposed to a given test water is determined by measuring the pH of test water after three successive 24 h periods of exposure within a seal coated pipe sample.

A.2 Materials and apparatus

A.2.1 **Paraffin wax, solventless epoxy, silicone resin** or other suitable sealing material.

A.2.2 **Test water**, having bicarbonate alkalinity of approximately 26 mg/l as $CaCO_3$, at equilibrium with the atmosphere (i.e. no artificially induced carbon dioxide level), and with a stable pH of 8 ± 0,1.

This water shall be produced by dissolving (0,027 8 ± 0,000 5) g of $CaCl_2$ (calcium chloride) and (0,042 8 ± 0,000 5) g of $NaHCO_3$ (sodium bicarbonate) in 1 l of distilled water.

A.2.3 **Petroleum jelly**.

A.3 Apparatus

A.3.1 **Glass plate**.

A.3.2 **pH meter**, having capacity to measure pH 0 to pH 14, with discrimination of a pH of 0,01 or better.

A.4 Preparation of test samples

The test shall be carried out using a nominally 500 mm long DN 150 seal coated and cement mortar lined pipe, with double spigot. The sample(s) shall be cut from pipes taken from normal production batches.

A.5 Procedure

A.5.1 Seal the pipe at its lower end in a shallow pan of molten paraffin wax, solventless epoxy, silicone resin or other suitable sealing material (A.2.1). Allow the material to harden.

A.5.2 Fill the pipe with test water (A.2.2) at room temperature.

A.5.3 Cover the top of the pipe with a glass plate (A.3.1) and seal it with petroleum jelly (A.2.3).

A.5.4 After (24 ± 1) h, dispose of the water, rinse and refill with test water (A.2.2).

A.5.5 Repeat A.5.4 twice, sampling the water after the third 24 h exposure period.

A.5.6 Determine the pH of the water sample using the pH meter (A.3.2) in accordance with ISO 10523.

Annex B
(normative)

Long term efficiency

B.1 Principle

The long term durability of a seal coat, applied to a cement mortar lining, is determined by measuring the sealing efficiency of the seal coat, after exposure to a cycle of swabbing, high velocity flowing water, pressurization and de-pressurization for a period of three months.

B.2 Materials

B.2.1 **Test water**, shall be the same as that defined for test water in Annex A.

B.3 Apparatus

B.3.1 **Soft foam swab**, bullet shaped, with a nominal density of 25 kg/m^3 to 35 kg/m^3, and an indentation hardness index (method A of ISO 2439:1997) of (200 ± 50) N. When placed inside the test pipe, the swab shall be of a diameter such that a compression of 15 % to 25 % is achieved.

B.3.2 **Pump**, capable of pumping to produce a flow velocity of 2 m/s in the test pipes.

B.3.3 **Pressure gauge**, capable of measuring pressure of at least 6 bar with a minimum discrimination of 0,5 bar.

B.3.4 **Water meter** or **alternative device**, to enable the measurement of a flow velocity of at least 2 m/s with a minimum discrimination of 0,2 m/s.

B.3.5 **Hand pump** or **alternative device**, to enable pressurization of the test pipeline.

B.3.6 **Flow control valve**, e.g. gate valve or alternative device, to enable setting of the flow velocity.

B.3.7 **Air bleed valve**, to enable the removal of air from the pipeline.

B.3.8 **Outlet/inlet valve**, to allow the pipeline to be filled with water and drained of water.

B.3.9 **Connecting pipeline components**, to enable the assembly and restraint of the pipeline.

B.3.10 **DN 150 flow development pipes (FDP)**, a minimum of 500 mm long, to establish uniform flow in the pipeline after a bend.

B.3.11 **Accumulator**, (optional device) to reduce pressure variations during the test.

B.3.12 **Pressure relief valve**, (optional device) to prevent over pressurization during the test.

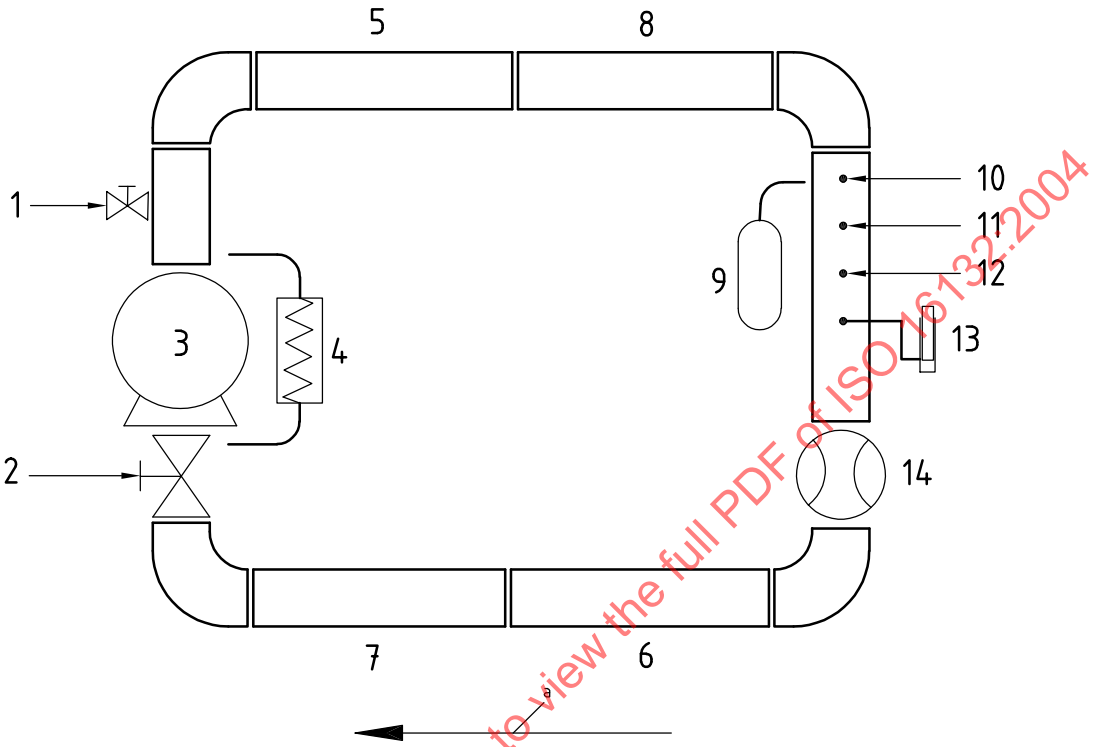
B.3.13 **Water cooler**, (optional device) to prevent overheating of the water during the test.

B.4 Preparation of test samples

The test shall be carried out using two nominally 500 mm long, DN 150 seal coated, cement mortar lined, ductile iron pipe samples. These samples shall be cut from two ductile iron pipes taken from normal production batches. Prior to the test, the seal coat and the swab shall be wetted and the swab shall be passed through each of the test samples once.

B.5 Procedure

B.5.1 Assemble the pipeline to allow water to be re-circulated, under pressure, through the samples in accordance with Figure B.1. Note that the pipe components will need to be held in place to withstand the forces generated by the internal water pressure.



Key

1 inlet/outlet valve
2 flow control valve
3 pump
4 water cooler (optional)
5, 6 flow development pipe to assist in developing constant flow
7, 8 pipe sample
9 accumulator (optional)
10 pressure relief valve (optional)
11 pressure gauge
12 air bleed valve
13 hand pressure pump
14 water meter

[a] Direction of flow.

Figure B.1 — Schematic diagram of durability pipeline

B.5.2 Fill the pipeline with the test water and bleed out any entrapped air.

B.5.3 Pump the water pressure up to a minimum pressure of 6 bar ± 1 bar for the duration of the test. Note that at the start of the test, small amounts of additional water may need to be added to the pipeline in order to maintain the pressure. The use of an optional accumulator will reduce pressure variations.

B.5.4 Start the pump and increase the flow velocity up to a minimum velocity of 2 m/s ± 0,2 m/s for the duration of the test. The water meter may be used to determine the flow velocity by noting the volume of water

passing through the pipeline in a set period of time, together with the knowledge of the internal diameter of the test samples. The test is to be conducted at ambient temperature. The temperature of the water in the pipeline may increase significantly due to the heat from the pump. To prevent this some of the water can be passed through a cooler (as shown in Figure B.1).

B.5.5 After one month of operation stop the flow, de-pressurize the pipeline, drain and discard the water, and remove the test samples. Wet the seal coat and the swab, then pass the swab once through each of the test samples.

B.5.6 Repeat steps B.5.1 to B.5.5 a further two times to complete 3 months of exposure.

B.5.7 Assess the sealing efficiency of the test samples, after the 3 month exposure, by testing each sample in accordance with Annex A.

Annex C
(normative)

Coating thickness measurement using test film

C.1 Principle

The average thickness of dry coating on a test film is determined to within 5 μm either by using a micrometer or by using a weight and area method.

C.2 Apparatus

C.2.1 **Test film**, of known thickness and mass/unit area, and having a minimum area of 5 000 mm^2.

C.2.2 **Micrometer**, having the capacity to measure to at least 10 mm, with a resolution of 5 μm or less.

C.2.3 **Tape measure**, at least 1 m in length, with a resolution of 1 mm or less.

C.2.4 **Analytical balance**, having at least 200 g capacity and a resolution of 0,01 g or less.

C.3 Preparation of test samples

C.3.1 Immediately prior to applying the coating, attach the piece of test film to the surface of the lining using self-adhesive tape.

NOTE The test film may be attached to the surface by applying tape to two edges of the film.

C.3.2 After applying the coating, remove the test film. Allow the coating on the film to dry/cure.

C.3.3 When the coating on the film is dry/cured, determine the dry film thickness using one or both of the methods C.4 or C.5.

C.4 Micrometer measurement method

C.4.1 Procedure

C.4.1.1 Select positions on the test film, where readings are to be taken, which are free from surface irregularities and are not less than 20 mm from the coated test film edge and not less than 20 mm apart.

For large areas of coated test film, select the number and distribution of the test areas to give a representative indication of the coated film thickness.

C.4.1.2 Position the micrometer (C.2.2) with its fixed jaw in contact with the coated side of the coated test film at the first test area. Gently screw home its movable jaw until a resistance is felt and no further movement of the jaw occurs on turning the ratchet.

Note the reading on the micrometer. Record the reading on a test sheet.

C.4.1.3 Release the micrometer and repeat the whole procedure in C.4.1.2, at each of the other test positions.

C.4.2 Calculation

C.4.2.1 Calculate the film thickness at each point by subtracting the mean thickness of the test film from each thickness reading.

NOTE The mean thickness of the test film, if unknown, may be determined in accordance with C.4.1.2, using an un-coated test film sample, taking the average of ten or more results thus obtained.

C.4.2.2 Calculate the mean value for the thickness of the coating to the nearest multiple of 5 μm or less (depending upon the accuracy of the micrometer).

C.5 Weight and area method — Procedure

C.5.1 In order to produce a rectangular sample, cut away areas of the coated test film which have adhesive tape attached.

C.5.2 Using a tape measure (C.2.3), measure the sides of the sample to an accuracy of 1 mm, and then determine the area of the remaining film, A, in square metres (m^2) to three significant figures.

C.5.3 Record the weight of the coated test film, G, in grams (g) to three significant figures using the balance (C.2.4).

C.5.4 Determine the coating thickness, T, in micron (μm), using the following equation:

$$T = \frac{1}{D} \times \left[\frac{G}{A} - W\right]$$

where

D is the volume mass of the coating dry film in grams per cubic centimetre (g/cm^3);

W is the mass per unit area of test film in grams per square metre (g/m^2).

Annex D
(normative)

Adhesion test

D.1 Principle

The adhesion of a seal coat to a cement mortar substrate is assessed by applying and removing adhesive tape. For seal coats with a specified minimum thickness of greater than 100 μm, a cross cut is made in the film before application of the adhesive tape. For seal coats with a specified minimum thickness of less than or equal to 100 μm, the adhesive tape is applied directly to the seal coat.

D.2 Apparatus

D.2.1 **Cutting tool**, e.g. sharp bladed knife, scalpel, high-speed micro abrasive disc or other cutting device.

D.2.2 **Cutting guide**, e.g. steel or other hard metal straight edge to ensure straight cuts.

D.2.3 **Soft brush**, for removing debris from the cut area.

D.2.4 **Light Source**, to assist in determining whether the cuts have been made through the film to the substrate.

D.2.5 **Adhesive Tape**, approximately 50 mm wide with a minimum peel adhesion strength of 35 N/100 mm width when measured in accordance with ASTM D3330-02, test method A.

D.3 Procedure

D.3.1 Select an area of seal coated surface and ensure that it is clean and dry.

D.3.2 Where applicable (see D.1) using the cutting tool (D.2.1) with the straight edge (D.2.2) as a guide, in one steady motion, make two cuts in the film, each about 50 mm long, which intersect near their middle with a smaller angle of between 30° and 45°. Remove any cutting debris using a soft brush (D.2.3). Using the light source (D.2.4), inspect the incisions to establish that the coating film has been penetrated. If not, repeat D.3.2.

D.3.3 Remove a length of adhesive tape (D.2.5) at least 75 mm long from the roll. Smooth the tape into place using finger pressure. Where a cross cut is used, place the centre of the tape at the intersection of the cuts in the same direction as the smaller angles. Smooth the tape into place using finger pressure in the area of the incisions.

D.3.4 Within (60 ± 30) s of application, remove the tape by grasping the free end and pulling it back on itself, without jerking, at an angle of approximately 180° to the plane of the seal coated lining.

D.3.5 Inspect the area of the tape for removal of seal coat from the mortar substrate. Only coating removed by adhesive failure of the bond between the seal coat and the mortar shall be considered in the assessment. Coating removed by cohesive failure, either within the seal coat or within the mortar (shown by a white/grey layer on the underside of the tape), shall not be considered in the assessment.

D.3.6 If a cross cut is used, determine the adhesion in terms of the following scale:

1) no peeling or removal of seal coat;

2) traces of peeling or removal along incisions or at the intersection;

3) jagged removal of seal coat along incisions up to 2 mm either side;